**Partnership for**

**Science & Engineering Practices**

**Summer Institute 2013**

Dimmitt Middle School

August 19, 2013

**Scientific Explanation:**

Participant Notebook



A Math and Science Partnership Award from Washington’s Office of Superintendent of Public Instruction

Why Explanation & Argumentation?

Use the space below to consider why the practices of explanation and argumentation are targets of the Partnership for Science & Engineering Practices.

|  |
| --- |
| **Why I think these practices are important** |
| **Notes** |
| **Questions** |

Writing Your Own Scientific Explanation

1. Examine the data table below.

2. Write a scientific explanation stating whether **fat** and **soap** are the same substance or different substances.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Student Data Collection for Fat and Soap** | | | | | |
|  | **Color** | **Hardness** | **Solubility** | **Melting Point** | **Density** |
| **Fat** | Off-white or slightly yellow | Soft, squishy | Water- no  Oil- yes | 37 degrees C | 0.92 g/cm3 |
| **Soap** | Milky white | Hard | Water-yes  Oil- no | Hotter than 100 degrees C | 0.84 g/cm3 |

**Scientific Explanation**

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**Examining a Student Explanation Part 1**

**Brandon’s First Explanation about Soap and Fat**

Fat and soap are both stuff but they are different substances. Fat is used for cooking and soap is used for washing. The are both things we use everyday. The data table is my evidence that they are different substances. Stuff can be different substances if you have the right data to show it.

What strengths do you see in this scientific explanation?

What feedback might you give to this student?

What do you think are some key features/components of a quality scientific explanation?

**Examining a Student Explanation Part 2**

**Brandon’s Second Explanation about Soap and Fat**

Fat and soap are different substances.

Fat is of white and soap is milky white.

Fat is soft squishy and soap is hard.

Fat is soluble in oil, but soap is not soluble in oil.

Fat has a melting point of 37 degrees C and soap has a melting point above 100 degrees C. Fat has a density of 0.92 g/cm3 and soap has a density of 0.84g/cm3. These are all properties. Because fat and soap have different properties, I know they are different.

What changes did Brandon make to his explanation?

In what ways did these changes make the explanation more clear?

If you were going to teach your students to write scientific explanations, how might you scaffold this for them?

**Launching the CER Framework**

As you watch the video of classroom instruction, record your observations of how the teacher introduced the CER Framework.

|  |  |  |
| --- | --- | --- |
| **Parts of a Scientific Explanation** | How did the teacher **define** this part? | What **example** did the teacher use to introduce this part? |
| **CLAIM** |  |  |
| **EVIDENCE** |  |  |
| **REASONING** |  |  |

Which of the parts of a scientific explanation do you think will be most difficult for students to master?

What could you do to make this part easier for students’ to understand and write?

**Connect to Everyday Examples Part 1**

Watch the short Audi commercial.

Record the parts of the CER framework that the girl uses.

|  |  |
| --- | --- |
| Claim |  |
| Evidence |  |
| Reasoning |  |

1. With a partner- improve the reasoning to be more complete.
2. Make and defend an alternate Claim.

# Connect to Everyday Examples Part 2

# Title: Baseball must mandate protective headgear for pitchers after latest injuries

**By:** Kevin Cowherd

Source: The Baltimore Sun

**Date:** June 26, 2013

**Directions:** As you read the text, identify elements of *Claim, Evidence, Reasoning* (and Rebuttal)

Star \* any Claims

Underline any Evidence

Circle any Reasoning

Box any Rebuttal

Go watch the video of Tampa Bay Rays pitcher Alex Cobb being hit on the head by a shot off the bat of the Kansas City Royals' Eric Hosmer, ball meeting skull sounding like a cantaloupe dropped on a sidewalk.

Go watch the clip of Toronto Blue Jays hurler J.A. Happ being drilled in the head by Desmond Jennings' line drive, the Rays outfielder gnawing on his jersey with growing alarm as trainers work feverishly over a downed, twitching Happ

Or watch Brandon McCarthy after he took a rocket to the head off Erick Aybar's bat, the dazed pitcher, then with the Oakland Athletics, sitting on the mound and rubbing his head over and over like he just took a haymaker from Wladimir Klitschko.

Then tell me baseball doesn't need to do something to protect pitchers.

And do something fast. Before someone gets killed.

"It's part of the game," Orioles' reliever Tommy Hunter says about these frightening shots pitchers have taken. "It [stinks]. But it's the game."

Maybe. But it's part of the game that has to be changed, pronto.

Look, we all know what's happening here.

Pitchers are throwing harder than ever. Batters are bigger and stronger than ever. And the mound is still 60-feet, 6-inches from the plate.

The laws of physics when ball meets bat haven't changed, either. It's a recipe for disaster. And this fatalistic attitude pitchers have — knowing they could have their heads taken off by a line drive, but shrugging it off as part of the game — seems as outdated as telephone booths.

Times change. Hockey goalies used to play without facemasks. That was insane, too.

The good news is that Major League Baseball is looking into protective headgear for pitchers. The proposal gaining the most attention would call for pitchers to wear a thin, padded lining under their caps made of Kevlar, the synthetic fiber found in bulletproof vests.

Hunter says he'd wear the lining, although he questions how much good it would do if a pitcher took a line drive that struck below his cap. But he has a simpler solution for pitchers who don't want to get whacked in the head: pitch to the corners of the plate.

Line drives back to the pitcher's head, he says, are "usually [the result of ] off-speed pitches that are up and over the plate where a [batter] can get extended. Throw every ball inside, stay on the corners, and you're not going to have a ball come back at your face."

OK, fine. But pitchers miss with pitches. They don't always hit the corners. They're not robots.

Orioles reliever T.J. McFarland missed with a pitch, and it could have cost him his life. This was in a summer game between his junior and senior years of high school. He threw a pitch that came back at him like a missile homing in on his face.

"It actually hit me in the perfect spot," McFarland says.

Except McFarland's definition of the "perfect spot" is a little different from yours and mine.

"It hit me underneath the eye socket," he says, "so it didn't shatter the eye socket. Left of my nose, so it didn't break my nose. I took 20 stitches."

"Off-speed pitch in the middle of the plate?" asks Hunter, who's been listening in.

McFarland nods.

"BAD off-speed pitch," he says grimly.

Fine, a cap lining wouldn't help with a line drive to the face. But if it helps deflect a shot off the skull and possible brain damage, isn't that better than nothing?

It is, say the Orioles pitchers I talked to. But guys would be reluctant to wear anything bulky, they say — anything different, anything they think throws off their balance and timing on the mound.

Major league pitchers can be total whack jobs about any little change in their routine.

"Some guys complain about the spring training hats we wear," starter Jason Hammel says. "The stretchy fit of it — even that annoys us."

How about being laid up in a hospital with a bad concussion because you now have the word "Rawlings" imprinted on your forehead from a scorching line drive — wouldn't that be even more annoying?

In the same breath, Hammel admits that his wife, Elissa, is worried sick about him getting clocked in the head by a line drive.

"Honestly," he says, "my wife was like: 'I'm gonna invent a [protective] cap and you're gonna have to wear it.'"

Me, I think it's baseball's job, not Elissa Hammel's, to find a way to protect pitchers from these terrifying shots like the one Alex Cobb took June 15 that left him with a concussion, vertigo, nausea and violent headaches.

And if it's a protective cap lining that baseball comes up with, make the pitchers wear it, period. If they resist, make them watch the video of Cobb nearly getting his head torn off. Make them watch it over and over again.

"Did you see the video?" I ask Hammel as our conversation ends.

He nods and makes a face.

"I watched it once," he says," and I couldn't watch it again."

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What challenges and successes did you have in identifying the CER elements?

What thoughts do you have about how to help your students to be clear in their use of the CER framework?

Explanation vs. Argumentation

What are your current ideas about how Explanation and Argument are similar and different?

|  |  |
| --- | --- |
| Similarities | |
| Explanation | Argumentation |
|  |  |

**Explanation Framework**

**Learning Sequence for Teaching & Practicing Scientific Explanations**

1. Make the framework explicit.

2. Model and critique explanations.

3. Provide a rationale for creating explanations.

4. Connect to everyday explanations.

5. Assess and provide feedback to students.

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**Rubric for Learning the Cl-Ev-R Scientific Explanation**

Claim

1. **Relevant** 🡪 The claim directly & clearly responds to the question.
2. **Stands-Alone** 🡪 The claim statement is complete (stands alone).



Evidence

1. **Appropriate** 🡪 Is this the right type of evidence for this claim?

(Discuss this in the “Reasoning” section.)

* 1. Validity: Measurements & observations are relevant.
  2. Validity: Controlled variables focus attention on key factors.

1. **Sufficient** 🡪 Is there enough evidence?
   1. Reliability: Repeated trials will increase confidence.
   2. Full Range: Enough different conditions/values of variables?
   3. Full Range: The explanation cites enough examples to represent the whole data set without being tedious.

Reasoning

1. **Stands-Out** 🡪 Is the reasoning obvious, or hard-to-spot?
   1. DO NOT repeat the Claim or the Question.
   2. DO NOT repeat the Evidence.
2. **Link** 🡪 Why this data should count as evidence.
   1. Why it’s the right type of measurement/observation.
   2. How the controls help to validate the link.
3. **Science Concept** 🡪 Use scientific concepts to connect reasoning to claim:
   1. Is this the right science concept to connect the reasoning to the claim?
   2. Is the science concept clear and correctly used?

Note: A fuller scientific explanation will also contain a “Rebuttal,” which describes alternative Claims, plus the Evidence and/or Reasoning that refute the alternative Claim.

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| --- | --- | --- | --- | --- |
| **Feedback Rubric for Scientific Explanations** | | | | |
|  | 4 | 3 | 2 | 1 |
| **Claim** | | | | |
| **Relevant** 🡪 The claim directly & clearly responds to the question. | Claim directly & clearly responds to the question. | Claim responds directly or clearly to the question. | Claim does not respond to the question. | No claim statement. |
| **Stands-Alone** 🡪 The claim statement is complete | Claim stands alone as a complete statement. | Minor missing piece to be a complete statement. | Vague or missing pieces. |
| **Evidence** | | | | |
| **Appropriate** 🡪 Is this the right type of evidence for this claim? | Data is relevant to the question.  Controls focus on key variables. | Data is relevant, but there are not enough controlled variables. | Cites evidence that is not relevant to claim. | No evidence cited. |
| **Sufficient** 🡪 Is there enough evidence? | Full range of data is cited, and that data has several conditions and repeated trials. | Cites unbalanced parts of the data, or data that is not from repeated trials. | Cites a minimal amount of data. |
| **Reasoning** | | | | |
| **Stands-Out** 🡪 Is the reasoning obvious, or hard-to-spot? | Reasoning statements stand out among other statements. | Reasoning is present, but is not obvious. | Repeats the Claim, Question, or Evidence. | No reasoning statements. |
| **Link** 🡪 Why this data should count as evidence. | Says how the data are the right data, and/or how the controls validate the data. | Minor piece is missing. | Attempts, but is unclear about how the data cited is relevant. |
| **Science Concept** 🡪 Use scientific concept to connect reasoning to claim | Includes appropriate and sufficient science concepts to explain why the evidence supports the claim. | Includes some appropriate science concepts for why the evidence supports the claim, but not sufficiently | Lightly addresses the science concepts, may fail to connect to claim or evidence, and/or may have some incomplete science concepts. |

**Three Parts of Feedback:**

1. Specifically describe what was done well (see rubric).
2. Clarify the target: evidence-based explanation with CLAIM + EVIDENCE + REASONING.
3. Specifically describe what must be done next to improve the explanation (see rubric).

**Notes:**

* Look at all parts to judge the strength and truth of the explanation. The truth of the Claim statement should not be judged by itself.
* Look elsewhere to judge the accuracy of the data.
* Pieces of reasoning sometimes get embedded in the Claim statement.

Provide a Rationale

Describe where Claim, Evidence, and/or Reasoning are used in other content areas.

How might a CER framework help **elementary students** in speaking, listening, and writing?

How might a CER framework help **middle school students** in speaking, listening, and writing?

What is important to both scientist explanations and everyday arguments, to make them effective?

Improve an Explanation

1. Reread your explanation on p. 3
2. Use the CER rubric to score your work.
3. In which part(s) of CER was your explanation most successful?
4. In which part(s) of CER could your explanation be improved?
5. Rewrite your explanation in the space below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
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**Scientific Explanation 2nd Draft**

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Learning Sequence for Scientific Explanations

1. Make the framework explicit.

2. Model and critique explanations.

3. Provide a rationale for creating explanations.

4. Connect to everyday explanations.

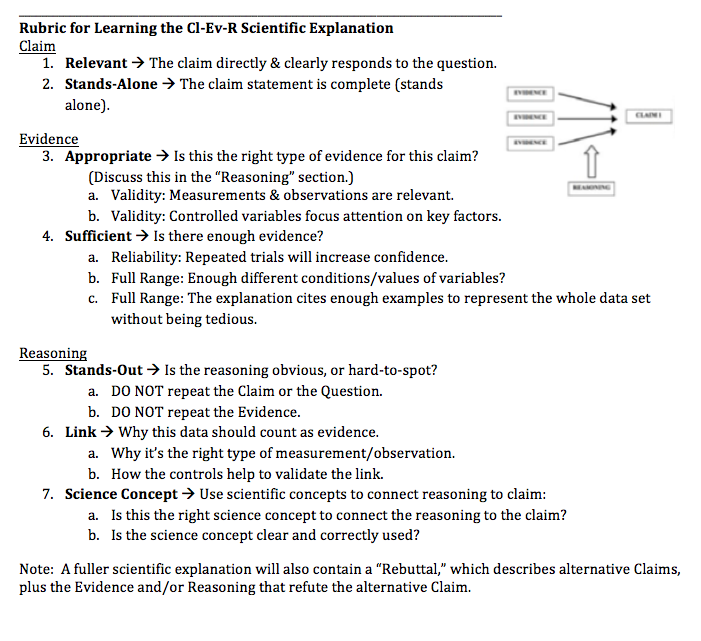
5. Assess and provide feedback to students.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
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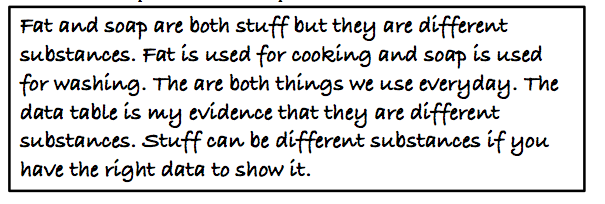
**Overview of a Learning Sequence**

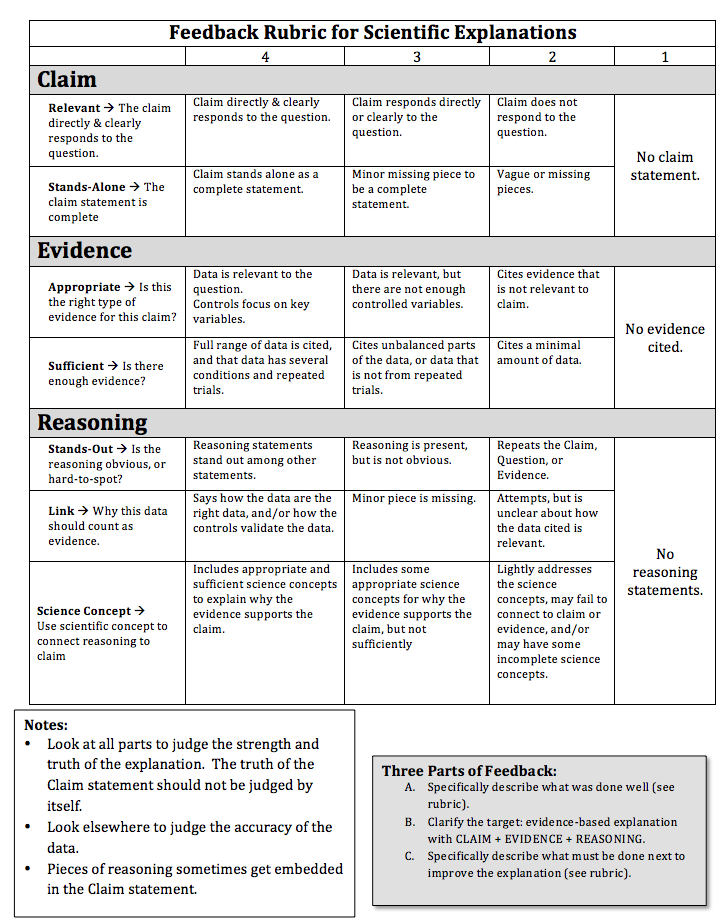
**1a. Initial Ideas:**

* Compose an Initial Scientific Explanation 🡪
* Make a public list of “elements of good scientific explanations.”

**1b. Discuss the CER Framework:**

**2a. Model and Critique Explanations:**

* Which parts of this scientific explanation are strong?
* Which parts could be improved?

**2b. Improve an Explanation:**

* Use the rubric to improve the student’s explanation about fat and soap.

The Beatles are the best band ever. Their song, “In My Life,” was very popular, and I really like it. Therefore, they are the best band ever.

**4a. Connect to Everyday Examples 🡪 Best Band:**

* Is this a scientific explanation? Why/not?
* What would make this argument more persuasive?

**4a. Connect to Everyday Examples 🡪 My Dad is a Space Alien:**

* Which parts of C-E-R is the girl using?
* Make and defend an alternative Claim.

**3. Provide a Rationale:**

* Describe where Claim, Evidence, and/or Reasoning are used in other courses in school.
* What is important to both scientific explanations and everyday arguments, to make them effective?

**5. Improve a Scientific Explanation:**

* Go back to your original scientific explanation. 🡪 Strengthen your scientific explanation.

Analyzing CER Questions

**Writing a Quality CER Question:**

* Identify opportunities for CER
  + Consider what data the students can use as evidence
  + Consider what scientific principles the students can apply to make sense of the data
* Writing the CER Question
  + Consider the clarity of the question- is it clear what claims the students could respond with?

**Examples of “weak’ CER Questions:**

High School Biology

* What is the role of DNA in the human body?
  + Difficult to use evidence for this question

Elementary Science

* What will happen when you mix salt and water?
  + Difficult to know what are the potential claims here (too vague)
  + Difficult to know what science concepts to apply

*Read through the following three sample questions. For each one, rate the question (poor, good, excellent) using the following three criteria: 1) Is the question clear in terms of what claim(s) a student should provide? 2) Is there data the students could use as evidence? 3) Is there reasoning students could use to explain why their evidence supports their claim? In addition, record any suggestions on how to improve the question.*

1. **Does the force change the speed of the vehicle?**

Clarity:

Data:

Reasoning:

Suggestions for Revisions:

1. **Why is a diamond a mineral and not a rock?**

Clarity:

Data:

Reasoning:

Suggestions for Revisions:

1. **Which bird beak is the best?**

Clarity:

Data:

Reasoning:

Suggestions for Revisions:

Constructing CER Questions

1. Identify a science concept or science instructional material you have used in the past.
2. Identify a place where students collect or are given data.
3. Write some questions that might lead to quality claims and the use of evidence to support the claims. Use p. 17 as a guide.

**Question:**

Clarity:

Data:

Reasoning:

Suggestions for Revisions:

**Question:**

Clarity:

Data:

Reasoning:

Suggestions for Revisions:

**CER Tools & StrategiesTable of Contents:**

Is it a Scientific Explanation?

Is it a Claim?

Is it Evidence?

2 Different CER Scaffolds

What counts as Evidence?

KLEWs chart

Question, Claim, Evidence Chart

Talk Moves

Notes